

RESPONSE TO OFFICE ACTION
Serial No. 09/776,329
Page 2 of 14

IN THE CLAIMS:

1. (Previously Presented) A method of film deposition for integrated circuit fabrication, comprising:
 - chemisorbing at least one element from a first precursor on a wafer surface;
 - chemisorbing at least one element from a second precursor on the wafer surface;
 - and
 - the at least one element from the first precursor and the at least one element from the second precursor co-reacted and chemisorbed to form a tantalum-nitride film.
2. (Original) The method of claim 1, wherein the first precursor and the second precursor are delivered sequentially to form the tantalum-nitride film.
3. (Cancelled)
4. (Original) A method of film deposition for integrated circuit fabrication, comprising:
 - chemisorbing a first layer on a substrate, the first layer selected from a first tantalum layer and a first nitride layer;
 - chemisorbing a second layer on the first layer, the second layer different from the first layer, the second layer selected from a second nitride layer and a second tantalum layer;
 - the first layer and the second layer in combination providing a tantalum-nitride layer; and
 - plasma annealing the tantalum-nitride layer to remove nitrogen therefrom.

RESPONSE TO OFFICE ACTION
Serial No. 09/776,329
Page 3 of 14

5. (Original) The method of claim 4, wherein the plasma annealing is performed with a plasma source material chemically non-reactive to the tantalum-nitride layer and having an atomic mass closer to nitrogen than tantalum.
6. (Previously Presented) The method of claim 4, wherein the plasma annealing is performed with plasma source material selected from argon (Ar), xenon (Xe), helium (He), neon (Ne), hydrogen (H₂), nitrogen (N₂), and combinations thereof.
7. (Original) The method of claim 4, further comprising sequentially repeating the chemisorbing of the first layer and the second layer along with interspersed plasma anneals to provide the tantalum-nitride layer.
8. (Original) The method of claim 4, further comprising sequentially repeating the chemisorbing of the first layer and the second layer to provide the tantalum-nitride layer.
9. (Cancelled)
10. (Cancelled)
11. (Currently Amended) A method of film deposition for integrated circuit fabrication, comprising:
providing a process system, the process system having a chamber;
locating a substrate in the process chamber;
providing a first reactive tantalum containing gas to the chamber;
chemisorbing a first tantalum layer on the substrate at least in partial response to the first reactive gas, ~~the first layer selected from a first tantalum layer and a first nitride layer;~~

256992

RESPONSE TO OFFICE ACTION
Serial No. 09/776,329
Page 4 of 14

conditioning the chamber with at least one of a purge gas or an evacuation;
providing a second reactive gas to the chamber; and
chemisorbing a second layer on the first layer at least in partial response to the second reactive gas, the second layer different from the first layer, the second layer selected from a second nitride layer and a second tantalum layer, wherein the tantalum containing gas is a tantalum based organo-metallic precursor or derivative thereof.

12. (Original) The method of claim 11, wherein the tantalum based organo-metallic precursor is selected from pentaethylmethylamino-tantalum (PEMAT), pentadiethylamino-tantalum (PDEAT), pentadimethylamino-tantalum (PDMAT), and derivatives thereof.

13. (Original) The method of claim 11, wherein the tantalum based organo-metallic precursor is selected from $Ta(NMe_2)_5$, $Ta(NEt_2)_5$, TBTDET, and tantalum halides.

14. (Original) The method of claim 11, wherein the second reactive gas is a nitrogen containing gas.

15. (Original) The method of claim 11, wherein the nitrogen containing gas is selected from an ammonia (NH_3) gas and a nitrogen plasma source gas.

16. (Previously Presented) A method of film deposition for integrated circuit fabrication, comprising:

providing at least one process system, the at least one process system having a chamber;
locating a substrate in the chamber;
providing a tantalum containing gas to the chamber;
chemisorbing a first layer on the substrate at least in partial response to the tantalum containing gas;

256992

RESPONSE TO OFFICE ACTION
Serial No. 09/776,329
Page 5 of 14

purging the chamber with at least one purge gas;
providing a nitrogen containing gas to the chamber;
chemisorbing a second layer on the first layer at least in partial response to
the nitrogen containing gas;

purging the chamber with the at least one purge gas; and
forming a plasma for annealing the second layer.

17. (Original) The method of claim 16, further comprising sequentially repeating the chemisorbing of the first layer, the purging of the chamber and the chemisorbing of the second layer to provide multiple tantalum nitride sublayers.

18. (Original) The method of claim 16, wherein the substrate is maintained approximately below a thermal decomposition temperature of the tantalum containing gas for chemisorbing of the first layer.

19. (Original) The method of claim 18, wherein the substrate is maintained approximately above the thermal decomposition temperature of the tantalum containing gas for the chemisorbing of the first layer.

20. (Original) The method of claim 18, wherein the purge gas is selected from the group of helium (He), neon (Ne), argon (Ar), hydrogen (H₂), nitrogen (N₂), and combinations thereof.

21. (Original) The method of claim 20; further comprising providing a plasma source gas to the chamber for ignition to provide the plasma.

22. (Original) The method of claim 21, wherein the plasma source gas and the at least one purge gas is argon (Ar).

256992

RESPONSE TO OFFICE ACTION
Serial No. 09/776,329
Page 6 of 14

23. (Original) The method of claim 18, wherein the nitrogen containing gas is ammonia (NH_3).

24-31. (Cancelled)

32. (Original) A method of film deposition for integrated circuit fabrication, comprising:

co-reacting a tantalum containing precursor and a nitrogen containing precursor to chemisorb a first layer on a wafer surface to provide a tantalum-nitride layer; and

plasma annealing the tantalum-nitride layer to remove nitrogen therefrom.

33. (Original) The method of claim 32, wherein the plasma annealing is performed with a plasma source material chemically non-reactive to the tantalum-nitride layer and having an atomic mass closer to nitrogen than tantalum.

34. (Previously Presented) The method of claim 33, wherein the plasma annealing is performed with plasma source material selected from argon (Ar), xenon (Xe), helium (He), hydrogen (H_2), nitrogen (N_2), neon (Ne), and combinations thereof.

35. (Previously Presented) A method of film deposition for integrated circuit fabrication, comprising:

providing a wafer to a chamber;

providing a plasma source gas containing nitrogen to the chamber;

igniting the plasma source gas to provide a plasma;

providing a tantalum containing gas to the chamber; and

co-reacting the tantalum containing gas and the plasma to chemisorb on a wafer surface a tantalum-nitride layer.

256992

RESPONSE TO OFFICE ACTION
Serial No. 09/776,329
Page 7 of 14

36. (Original) A method of thin film deposition for integrated circuit fabrication, comprising:
providing a chamber;
providing a plasma source gas containing nitrogen to the chamber;
igniting the plasma source gas to provide a plasma;
chemisorbing a nitrogen layer on a substrate;
providing a precursor gas containing tantalum to the chamber; and
chemisorbing a tantalum layer on the substrate;
wherein the nitrogen layer and the tantalum layer in combination provide a tantalum-nitride layer.

37. (Cancelled)

38. (Currently Amended) A method of film deposition for integrated circuit fabrication, comprising:

providing a process system, the process system having a chamber;
locating a substrate in the process chamber;
providing a tantalum containing gas to the chamber;
providing a nitrogen containing gas to the chamber;
chemisorbing tantalum and nitrogen from the tantalum containing gas and the nitrogen containing gas to provide a tantalum-nitride layer on the substrate; and

~~The method of claim 37, further comprising plasma annealing the tantalum-nitride layer.~~

39. (Currently Amended) The method of claim ~~[[37]]~~ 38, wherein the tantalum containing gas is a tantalum based organo-metallic precursor or a derivative thereof.

BEST AVAILABLE COPY

256992

RESPONSE TO OFFICE ACTION
Serial No. 09/776,329
Page 8 of 14

40. (Original) The method of claim 39, wherein the tantalum based organo-metallic precursor is selected from pentaethylmethylamino-tantalum (PEMAT), pentadiethylamino-tantalum (PDEAT), pentadimethylamino-tantalum (PDMAT), and derivatives thereof.

41. (Original) The method of claim 39 wherein the tantalum based organo-metallic precursor is selected from $Ta(NMe_2)_5$, $Ta(NEt_2)_5$, TBTDET, and tantalum halides.

42. (Original) The method of claim 39 wherein the nitrogen containing gas is ammonia (NH_3).

43. (Currently Amended) The method of claim ~~[[37]]~~ 38, wherein the substrate is maintained approximately below a thermal decomposition temperature of the tantalum containing gas.

44. (Currently Amended) The method of claim ~~[[37]]~~ 38, wherein the substrate is maintained approximately above a thermal decomposition temperature of the tantalum containing gas.

45. (Previously Presented) A method of forming a barrier layer structure and an interconnect structure for use in integrated circuit fabrication, comprising:

providing a substrate having a dielectric layer thereon, wherein the dielectric layer has recesses formed to expose portions of a surface of the substrate;

forming at least one tantalum-nitride layer on at least portions of the dielectric layer and the substrate surface, the at least one tantalum-nitride layer formed using co-reaction chemisorption of tantalum containing and nitrogen containing precursor gases;

etching through portions of the at least one tantalum-nitride later disposed within the recesses; and

RESPONSE TO OFFICE ACTION
Serial No. 09/776,329
Page 9 of 14

depositing at least one metal at least in part in the recesses;
wherein the at least one tantalum-nitride layer mitigates migration of elements
of the at least one metal to the dielectric layer.

46. (Original) The method of claim 45, wherein the at least one metal is selected
from aluminum (Al), copper (Cu), tungsten (W) or a combination thereof.

47. (Original) The method of claim 45, wherein the at least one metal is a
refractory metal selected from titanium (Ti), tungsten (W), vanadium (V), niobium (Nb),
tantalum (Ta), zirconium (Zr), hafnium (Hf), chromium (Cr), and molybdenum (Mo).

48-50. (Cancelled)

51. (New) A method of film deposition for integrated circuit fabrication
comprising:

- providing a process system, the process system having a chamber;
- locating a substrate in the process chamber;
- providing a tantalum containing gas to the chamber wherein the tantalum
containing gas is a tantalum based organo-metallic precursor or a derivative thereof;
- providing a nitrogen containing gas to the chamber; and
- chemisorbing tantalum and nitrogen from the tantalum containing gas and the
nitrogen containing gas to provide a tantalum-nitride layer on the substrate.

52. (New) The method of claim 51, wherein the tantalum based organo-metallic
precursor is selected from pentaethylmethylamino-tantalum (PEMAT),
pentadiethylamino-tantalum (PDEAT), pentadimethylamino-tantalum (PDMAT), and
derivatives thereof.

RESPONSE TO OFFICE ACTION
Serial No. 09/776,329
Page 10 of 14

53. (New) The method of claim 51, wherein the tantalum based organo-metallic precursor is selected from $Ta(NMe_2)_5$, $Ta(NEt_2)_5$, TBTDET, and tantalum halides.

54. (New) The method of claim 51, wherein the nitrogen containing gas is ammonia (NH_3).

55. (New) The method of claim 51, wherein the substrate is maintained approximately below a thermal decomposition temperature of the tantalum containing gas.

56. (New) The method of claim 51, wherein the substrate is maintained approximately above a thermal decomposition temperature of the tantalum containing gas.

57. (New) A method of film deposition for integrated circuit fabrication comprising:

- providing a process system, the process system having a chamber;
- locating a substrate in the process chamber;
- providing a tantalum containing gas to the chamber;
- providing a nitrogen containing gas to the chamber;
- chemisorbing tantalum and nitrogen from the tantalum containing gas and the nitrogen containing gas to provide a tantalum-nitride layer on the substrate; and
- maintaining the substrate approximately below a thermal decomposition temperature of the tantalum containing gas.

58. (New) A method of film deposition for integrated circuit fabrication comprising:

- providing a process system, the process system having a chamber;
- locating a substrate in the process chamber;

RESPONSE TO OFFICE ACTION

Serial No. 09/776,329

Page 11 of 14

providing a tantalum containing gas to the chamber;
providing a nitrogen containing gas to the chamber;
chemisorbing tantalum and nitrogen from the tantalum containing gas and the
nitrogen containing gas to provide a tantalum-nitride layer on the substrate; and
maintaining the substrate approximately above a thermal decomposition
temperature of the tantalum containing gas.

256992